HISTORICAL PRESENCE OF CHINOOK SALMON AND STEELHEAD IN THE CALAVERAS RIVER

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ABSTRACT

Interest is great for projects restoring steelhead (*Oncorhynchus mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha*) to drainages where they have historically existed and where there is good quality habitat upstream of instream barriers. The Calaveras River has garnered renewed attention for its potential to support these anadromous fish. I evaluated migration opportunity in the Calaveras River, and whether these salmonids could have been present in the river historically, by comparing historical anecdotal and documented observations of Chinook salmon and steelhead to recorded flows in the river and Mormon Slough, the primary migration corridors. Collected data show these fish used the river before New Hogan Dam was constructed in 1964. Three different runs may have used the river including fall-, late-fall- and spring-run salmon, and steelhead before the construction of New Hogan Dam. Fall and possibly winter run and steelhead used the river after dam construction. The timing and amount of flows in the Calaveras River, both before and after the construction of New Hogan Dam, provided ample opportunity for salmonids to migrate up the river in the fall, winter and spring seasons when they were observed. Flows less than 2.8 m^3s^{-1} (100 ft^3 sec^{-1}) can attract fish into the lower river channel and this was likely the case in the past, as well. Even in dry years of the past, flows in the river exceeded 5.6 m^3s^{-1} (200 ft^3 sec^{-1}), enough for fish to migrate and spawn. Today, instream barriers and river regulation, which reduced the number of high flow events, has led to fewer opportunities for salmon to enter the river and move upstream to spawning areas even though upstream spawning conditions are still adequate.

KEYWORDS – Calaveras River, Chinook salmon, steelhead, historical presence

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Introduction

The San Joaquin River at one time in the past had the state's largest run of spring-run Chinook salmon (*Oncorhynchus tshawytscha*) (USFWS 1995) and the basin also had late-fall run and fall-run Chinook salmon and steelhead (*Oncorhynchus mykiss*) (USFWS 1995). The Stanislaus, Mokelumne, and Cosumnes Rivers, all adjacent San Joaquin River tributaries to the Calaveras River, had Chinook salmon and steelhead populations (DFG 1993, Yoshiyama et al. 1998). Interest is great for projects restoring these fish to drainages where they have historically existed and where there is good quality habitat upstream of instream barriers. The Calaveras River has garnered renewed attention for its potential to support anadromous fish such as steelhead and Chinook salmon. Streamflow is the principal factor currently limiting salmonids in the Calaveras river (CALFED Bay-Delta Program 2000). Historical documentation prior to 1970 of the presence of Chinook salmon and steelhead in the river is limited. Regular surveys of adult escapement or spawning had not been conducted in the Calaveras River until recent United States Fish and Wildlife Service (USFWS) surveys. Presently, anadromous fish have access to 58 km of the river between New Hogan Dam and the San Joaquin River when flows permit. This study compares observations of salmon and steelhead in the Calaveras River with San Joaquin River Basin salmonid life history, salmonids found historically in adjacent drainages, and seasonal availability of flows and channel migration conditions, evaluating whether adult salmon and steelhead could have historically been present in the Calaveras River.

The watershed of the Calaveras River is about 1040 km^2 (400 m^2) with headwater elevations of about 1500 m (5000 ft) (Figure 1). The Calaveras River's primary water source is seasonal rainfall due to its elevation below typical snow level. Approximately 93 % of all runoff, and most flooding, occurs between November and April (USFWS 1998). Rain is generally moderate but can be prolonged over several days causing floods that are characterized by high, but short, peak flows. The Calaveras River hydrologic record, before river regulation, shows higher flow in winter and spring and periods of low to no flow in late summer and fall. After regulation by New Hogan Reservoir in 1964, winter and spring flow peaks have been lower and water now flows year-round between New Hogan Dam and Bellota Weir (Figure 2). 29 km upstream of the river mouth the river is split by Bellota Weir into two channels, the old Calaveras River channel and Mormon Slough. Mormon Slough is the primary channel in the lower river used by migrating anadromous fish to access upstream spawning areas in the mainstem Calaveras River upstream of Bellota Wier. Historical descriptions of Mormon Slough indicated higher flow in winter and spring and periods of low to no flow in late summer and fall. Mormon Slough still experiences dry periods in summer and early fall as it did under the pre-1964 unregulated hydrologic regime. Currently, flows are controlled by Bellota Weir into Mormon Slough. The channel is filled with irrigation water until around mid-October when irrigation season ends. Following the end of the irrigation season, fall flows in Mormon Slough frequently drop to levels less than 0.57 to 0.85 m^3s^{-1} (20-30 ft^3 sec^{-1}), which may prevent spawning migration during fall (FFC 2004). Many channel segments go dry through the winter except during storms when runoff and high flows enter the channel or overtop Bellota Weir. Once flows recede, the channel goes dry except for disconnected pools where salmon become stranded.

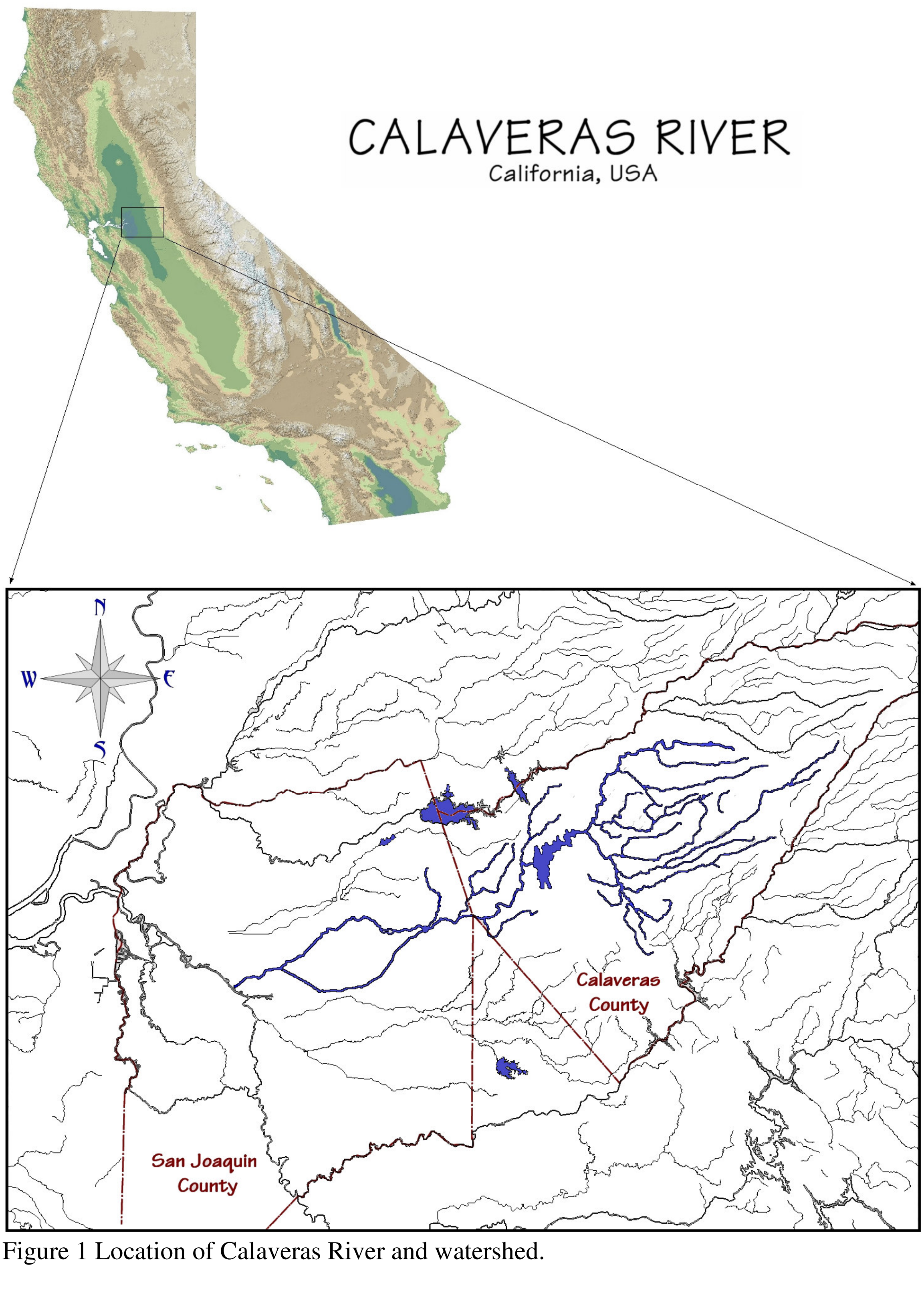

Figure 1 Location of Calaveras River and watershed.

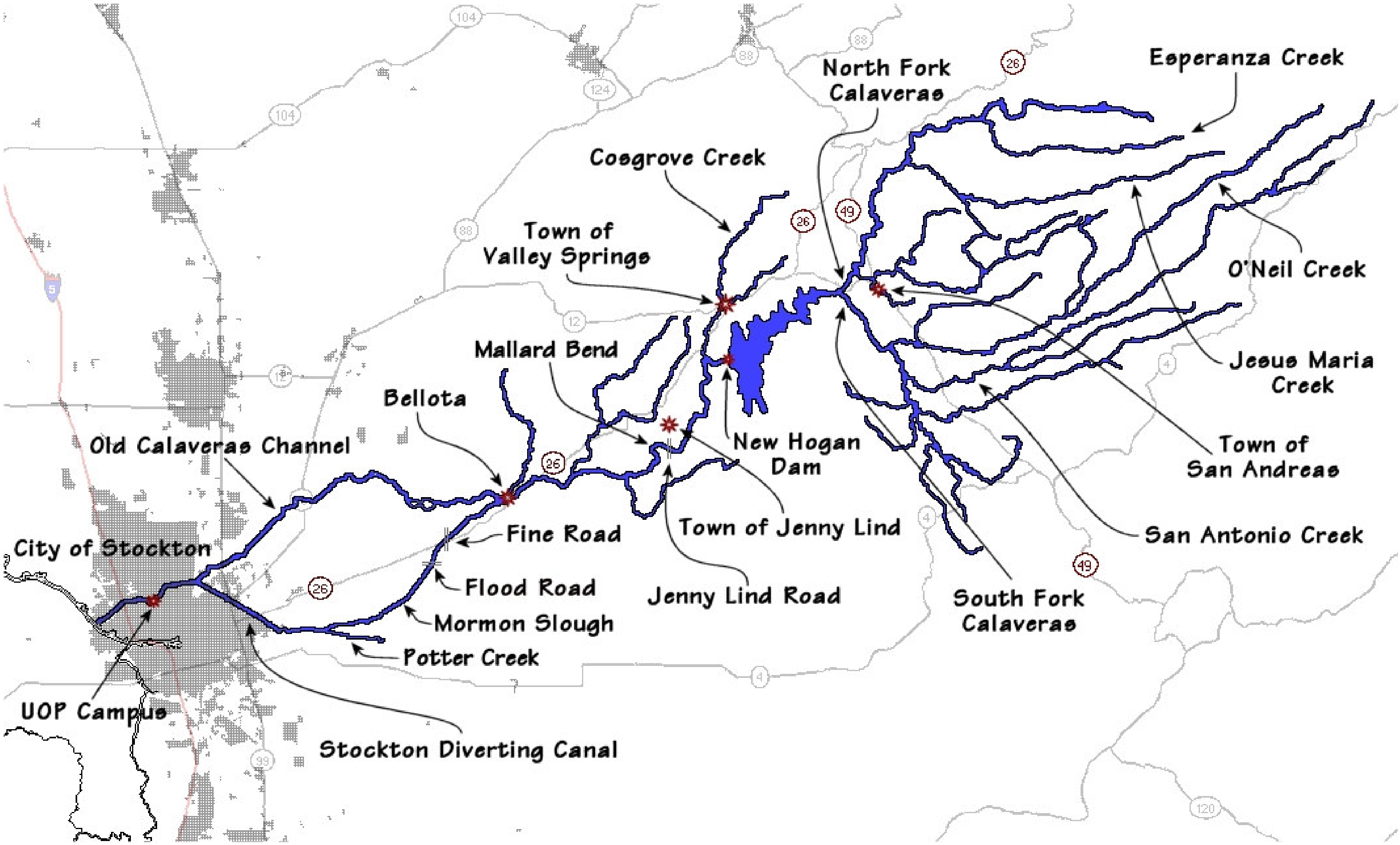

Figure 2. Map of the Calaveras River and major tributaries showing the location of significant barriers and features.

According to historical accounts the valley reach of the Calaveras River was a large floodplain with many braided streams during times of high water (Tinkham 1880). The Calaveras River area has changed from an uncontrolled floodplain of sloughs and oak groves of the 1860s to today's system of controlled channels, dams, and levees. The city of Stockton first impounded the river for flood control by building Hogan dam in 1930 near Valley Springs, about 11.2 km (7 mi) upstream of Jenny Lind (Figure 2). Later, the United States Army Corps of Engineers (USACE) completed New Hogan Dam in 1964, submerging Hogan Dam behind it. New Hogan Reservoir's large capacity (401 X 10^6 m^3 or 325,000 acre-ft yr^{-1}) relative to the average annual inflow (194 X 10^6 m^3 or 157,000 acre-ft yr^{-1}) means spills occur only in wet years. New Hogan Reservoir substantially altered the timing, magnitude and duration of flows in the river. In 1978, Stockton East Water District began operating a 1.84-m^3s^{-1} (65 ft^3 sec^{-1}) water diversion at Bellota Weir for a water treatment plant. The river's former intermittent seasonal flow was replaced with a steady year-round flow delivering water from New Hogan Dam to the plant's diversion at Bellota. In general, instream flow releases during the irrigation season (April - October) range from 4.25 to 7.08 m^3s^{-1} (150-250 ft^3 sec^{-1}) (DFG 1993).

Lindley et al. (2006) modeled historical distribution of summer rearing habitat for anadromous *O. mykiss* and included San Antonio, San Domingo, O'Neil, and McKinney Creeks, all tributaries upstream of New Hogan Dam. They also propose an historical independent population of steelhead for these creeks and for the mainstem Calaveras River. DFG (1963) noted that zero flows or flows less than one cubic foot per second were "common in the late summer and fall months downstream of old Hogan Dam. During most years, several days or even months of no flow can be expected in this reach starting in July and continuing through November." However, deep pools in the six-mile reach from New Hogan Dam to the town of Jenny Lind provide suitable summer holding areas for salmon and resident trout in all but the driest years (CALFED Bay-Delta Program 2000). DFG (1963) reported that tributary streams likely had water temperatures and habitat suitable for cold and warm water fish during summer months. Calaveras County trout fishing records indicate major tributaries had permanent flows from cold springs at the 360-600-m elevation (1200-2000 ft) supplying sufficient cold water to support self-sustaining populations of German brown trout and rainbow trout (DFG 1963). During high stream flows in spring trout redistributed themselves both upstream and downstream in the tributary streams making trout fishing possible during late spring (DFG 1963). DFG (1963) also notes that O'Neil Creek had permanent flow during normal and wet years near Sheep Ranch; the North Fork Calaveras River and San Antonio Creek had perennial flows at the Railroad Flat-Sheep Ranch Road crossing in 1961; and Jesus Maria and O'Neil Creeks had perennial flows in the vicinity of the Railroad Flat-Sheep Ranch Road. Upstream of Hogan reservoir, all streams in the Calaveras River drainage were dry in late summer where they cross Highway 49 (DFG 1963).

Summer and early fall streamflow patterns are different before and after construction of New Hogan Dam (Figure 3). Under pre-dam conditions the months of highest flows were typically January through April, and the months of lowest flows were September to mid-November. Under post-dam conditions summer time flows increase as water is released for irrigation, and winter and early spring time flows are of much less magnitude due to control of water released from the reservoir. Prior to New Hogan Dam, the driest recorded year was 1961 with annual mean streamflow of just 0.45 m^3s^{-1} (16 ft^3 sec^{-1}). The driest year after the river was regulated by New Hogan Dam was 1977 with an annual mean streamflow of 2.32 m^3s^{-1} (81.8 ft^3 sec^{-1}). The dam also significantly reduced floods on the river. The largest daily mean flow was over 878 m^3s^{-1} (31,000 ft^3 sec^{-1}) before the dam was built and less than 227 m^3s^{-1} (8000 ft^3 sec^{-1}) afterwards. Mean of monthly flows for dry and wet water years are similar in both pre- and post-New Hogan Dam periods with rainfall-induced peaks occuring in winter and early spring. However, they differ in that summer and early fall flows are elevated after flow regulation began (Figures 4 and 5). During dry years between 1907 and 1950 there were about two to three months each year with monthly mean streamflow less than 0.42 m^3s^{-1} (15 ft^3 sec^{-1}) at Jenny Lind (typically August and September). Once New Hogan Dam was built, there have been no months in which monthly mean streamflow was less than 0.42 m^3s^{-1} (15 ft^3 sec^{-1}) at New Hogan Dam gauge except in 1977, the driest year on record. The number of years classified as wet or dry is the same in the pre- and post-dam regulation period. However, after river regulation the number of peak flows over 2.8 m^3s^{-1} drops dramatically in dry years from 30 to 9 events , potentially reducing migration opportunities for salmonids in drier years (Table 3).

Table 1. Number of monthly peak flows over 2.8 m^3s^{-1} (100 ft^3 sec^{-1}) during potential Chinook salmon migration period (November to April) in dry and wet years. Period of record for Jenny Lind (1907-1963) and New Hogan Dam (1964-2002) gauges.

Gauge (Period of Record)	# of Dry Years in Period of Record	# of Wet Years in Period of Record	Dry Years # of Monthly Peak Flows > 2.8 m^3s^{-1} November-April	Wet Years # of Monthly Peak Flows > 2.8 m^3s^{-1} November-April
Jenny Lind (1907-1963)	7	15	30	76
New Hogan Dam (1964-2002)	7	15	9	61

Because fall-run Chinook salmon and potentially steelhead were historically found in the neighboring Cosumnes River, and the two rivers have similar elevational and hydrologic settings, a comparison of the two rivers is worthwhile. The Cosumnes River watershed is similar in size (1430 km^2 or 550 m^2) and elevation (1290 m or 4300 ft) to the Calaveras. Like the Calaveras, the Cosumnes River, a tributary to the Mokelumne River, is almost exclusively fed by rainfall during winter and spring rains and the annual hydrograph is similarly characterized by a high-water period during winter rains followed by a low-flow period during the dry summer months. Floods in the river usually result from intense rainfall, are generally very flashy, and typically last for only a few days (Jones and Stokes 2003). According to Yoshiyama et al. (2001) the Cosumnes River has been an intermittent stream and from earliest times offered limited access to salmon. Mean daily flows are less than 28.32 m^3s^{-1} (1000 ft^3 sec^{-1}) 85 % of the time (313 days in a year, on average), exceed 56.64 m^3s^{-1} (2000 ft^3 sec^{-1}) 4.9 % of the time (18 days per year), and exceed 141.6 m^3s^{-1} (5000 ft^3 sec^{-1}) 1 % of time (4 days per year) (Jones and Stokes 2003). Similarly, Calaveras River mean daily flows are less than 28.32 m^3s^{-1} (1000 ft^3 sec^{-1}) 95 % of the time (on average 346 days in a year), exceed 56.64 m^3s^{-1} (2000 ft^3 sec^{-1}) 2.38 % of the time (8.7 days per year), and exceed 141.6 m^3s^{-1} (5000 ft^3 sec^{-1}) 0.6 % of the time (2.26 days per year).

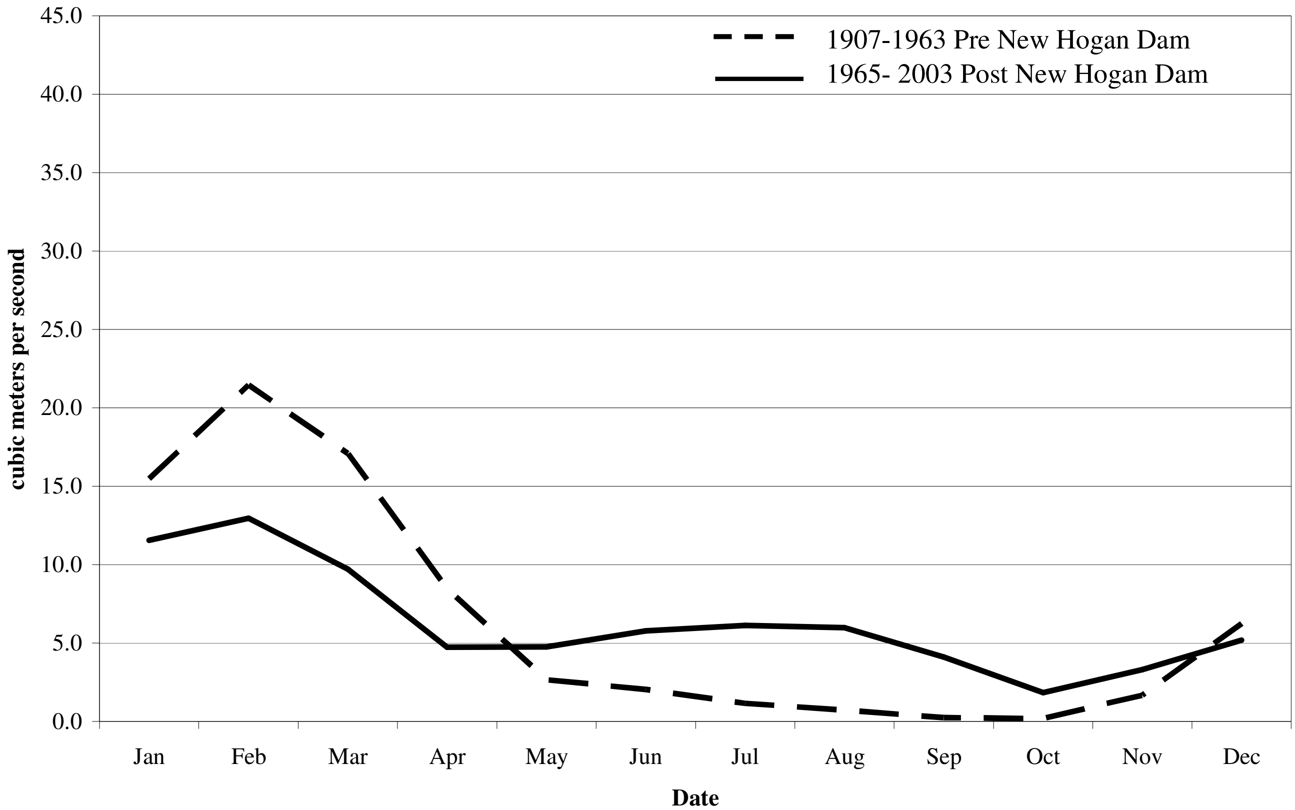

Figure 3. Pre- and post-New Hogan Dam mean of monthly streamflow based on daily average streamflow data. USGS Jenny Lind, 1907-1963, data from USGS. New Hogan Dam, 1965-2003, data from USACE.

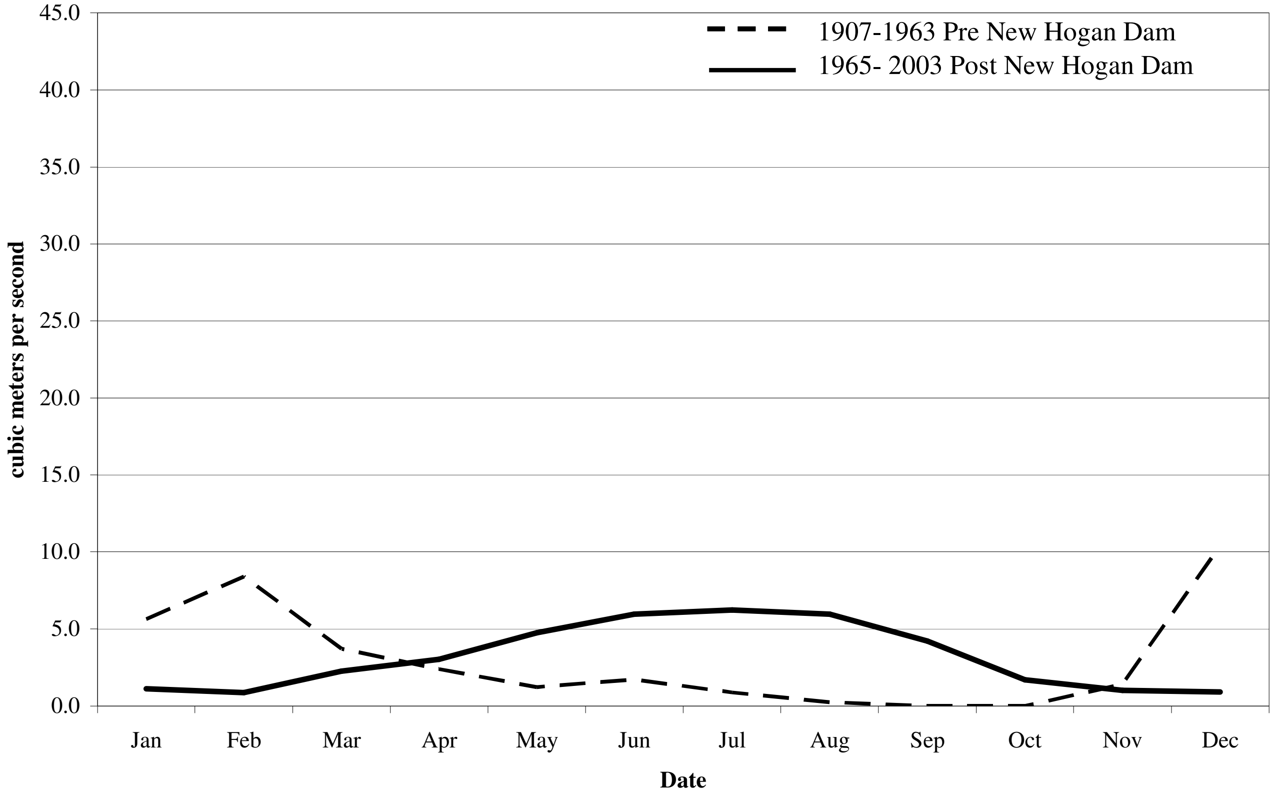

Figure 4. Pre- and post-New Hogan dam mean of monthly streamflow for dry water years for period 1907-2003. Based on daily average streamflow data. USACE New Hogan Dam (1965-2003) and USGS Jenny Lind (1907-1963).

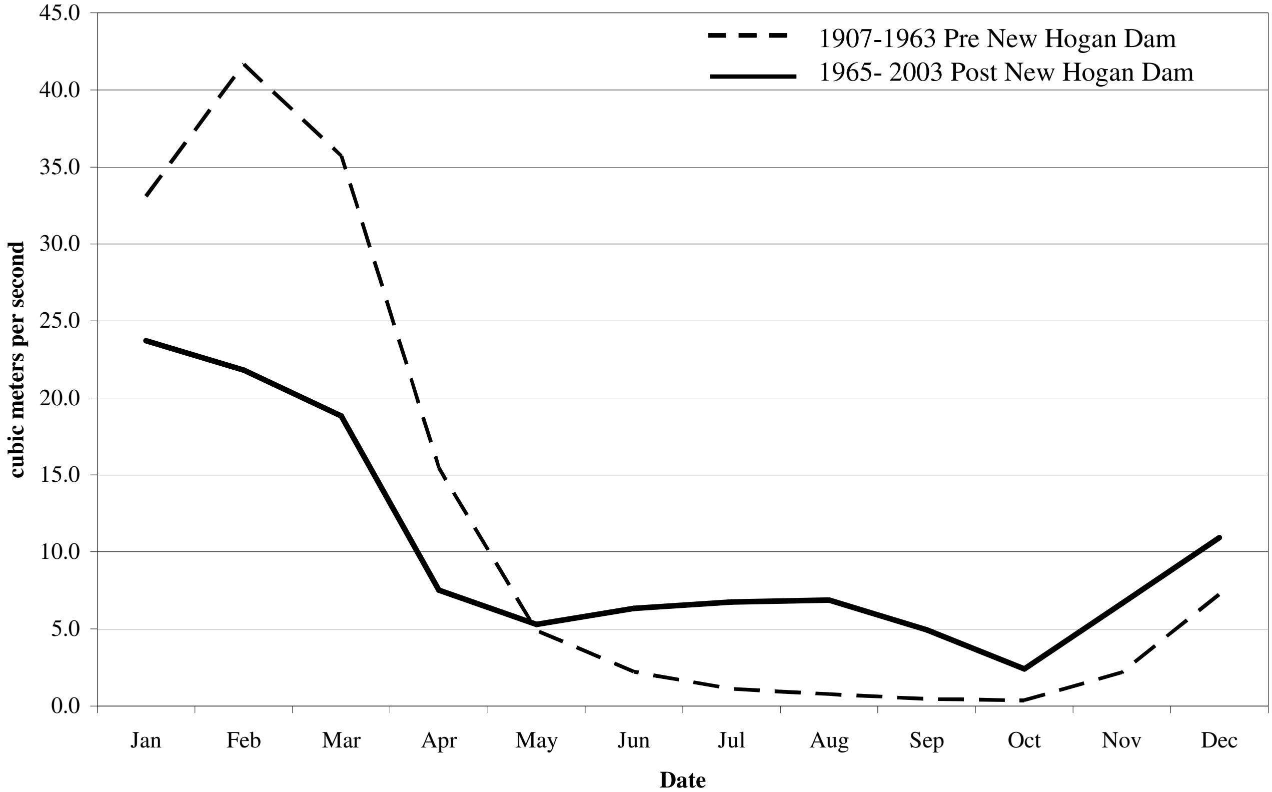

Figure 5. Pre- and post-New Hogan Dam mean of monthly streamflow for wet water years for period 1907-2003. Based on daily average streamflow data. USACE New Hogan Dam (1965-2003) and USGS Jenny Lind (1907-1963).

Baker and Morhardt (2001) described a generalized life history for Chinook salmon in the San Joaquin River and major tributaries, stating that the spawning run typically extends from October through December, with the bulk of the run appearing in the tributaries in November. Spawners are occasionally seen in September and are frequently reported in small numbers in January. The young fish emerge from the streambed from late December through April. Some fry do not join the spring emigration, but instead remain in the tributaries over the summer, emigrating in October and November as yearlings (Baker and Morhardt 2001). In the Sacramento River Basin, this period is one to two months earlier. According to Yoshiyama et al. (1998) fall-run of the Tuolumne River migrate from October to early January. S.P. Cramer and Associates documented Chinook salmon migrating up the Stanislaus River in 2003 as early as September 19, and in 2004 as early as Sept 27.

Life history timing for late-fall run in the San Joaquin River Basin is not well documented. According to the California Department of Fish and Game (DFG) (1993) late-fall run Chinook migrate into San Joaquin River Basin tributaries from mid-October through mid-April. The fish spawn from January through mid-April and egg incubation occurs from January through June. Rearing and emigration of fry and smolts occurs from April through mid-October. Significant emigration of naturally produced juveniles occurs through November and December and possibly into January. S.P. Cramer and Associates (SPC) documented migrating adult female Chinook salmon in the Stanislaus River (the next parallel drainage to the south of the Calaveras River) as late as February 14, 2004 during their first year of monitoring. Migration and spawning timing for late-fall run of the Sacramento River Basin is similar.

Neither the life-history nor migration period of spring-run on the San Joaquin River is well documented. Generally, spring-run salmon enter rivers during high water of spring runoff and remain until the spawning season the next fall. In the San Joaquin drainage, the upper San Joaquin River supported what may have been the largest population of spring-run salmon in the state until 1947. In the Merced River, a large tributary to the San Joaquin River, spring run had disappeared by 1929 and there has not been a successful spawn of Chinook salmon in the San Joaquin River since spring of 1946 (Skinner 1958). According to Warner (1991) 1950 was the last run of spring-run up the San Joaquin River. However, from June 20 to August 11, 2000 the Fishery Foundation of California documented spring-run, originating from the Feather River hatchery in the Sacramento River system, in the Stanislaus River in the deeper pools of Goodwin Canyon as well as in deep pools between Knights Ferry and Orange Blossom (FFC 2002). Sacramento River Basin spring-run migrate from March-September with the spawning period in late August-October. Whether this timing is earlier, later, or similar to the San Joaquin Basin is not known.

Winter run are not historically known to have used the San Joaquin River Basin. However, winter run have used the Calaveras and Stanislaus Rivers in recent years. Their timing corresponds to winter-run salmon of the Sacramento River Basin, which migrate from December to July, and spawn from late April to early August. In the Sacramento River Basin, juvenile winter run emerge from July - October and can spend up to 10 months in freshwater (Yoshiyama et al. 1998). This period corresponds to observations of the so-called winter run in the Calaveras River in the 1970s and 1980s. In 1975, DFG biologists observed fish migrating as early as

January and spawning in April to July or holding in pools downstream of New Hogan Dam in June. Low autumn flows in some years apparently caused juveniles to hold over and migrate out as yearlings (USFWS 1993). DFG documented Chinook salmon yearlings in 1974, 1977, and 1987 in February through June. Interestingly, in June 2000 FFC biologists documented what they believe were small numbers of stray winter-run adult salmon in the Stanislaus River that were in poor condition and had already spawned. Yearling Chinook were also observed in low numbers over summering in the river upstream of Lovers Leap in the Stanislaus River (FFC 2002).

Steelhead, the anadromous life history form of rainbow trout, *Oncorhynchus mykis,* are broadly characterized into winter- and summer-runs (FFC 2004). Only winter steelhead are believed to have occurred in the San Joaquin River Basin, entering spawning streams in fall or winter, and spawning a few months later in winter or late spring (Meehan and Bjornn 1991, Behnke 1992 as cited in FFC 2004). However, no information on the run timing or life history of steelhead that occurred in the San Joaquin River Basin is available apart from observations in October and November 1940 and October 1942 in the Tuolumne River (CDFG unpublished as cited in FFC 2004).

Historical presence of salmon and steelhead in neighboring drainages provides another point of comparison for their presence in the Calaveras River. Only a fall run is definitely known to have occurred in the Cosumnes River. However, the presence of rainbow trout suggests that steelhead may have existed also in this river (FFC 2004). Similar to the Calaveras River, salmon generally cannot ascend the Cosumnes River until late October to November, when adequate flows from rainfall occur (DFG 1993). Adults are stranded in shallow areas in low-flow conditions. In years of low rainfall, salmon do not successfully migrate to suitable spawning areas upstream (USFWS 1998). Clark (1929) reported the presence of “a considerable run” which he stated to be equal to that of the Mokelumne River.

Fall-run Chinook salmon and steelhead presently occur in the lower Mokelumne River (USFWS 1998). Historically, the river supported fall- and spring-run Chinook salmon, and Yoshiyama et al. (2001) suggest that a late-fall run also occurred at one time. Spring-run Chinook have been extirpated in the mainstem San Joaquin River and spring-run salmon were eliminated from the Mokelumne River when Pardee Dam was completed in 1928, although remnant spring-run fish are suspected of having persisted in the Mokelumne River until construction of Camanche Reservoir in 1963 completely cut off access to upstream reaches (USFWS 1998). Steelhead historically had substantial annual runs in the Mokelumne River. The native steelhead run in this river system is extinct (USFWS 1998). Today, steelhead are maintained in the river by hatchery plants, and fewer than 100 naturally spawning and hatchery steelhead occur in the river (G. Castillo, USFWS, pers. comm.).

The earliest historical references to salmon seem to indicate that late-fall run salmon actually occurred in the Mokelumne River at least until the mid-1800s. Historical journal accounts from the late 1820s trapping period and the 1849 Gold Rush describe purchases of salmon in “fine” condition on January 22, 1828 (Sullivan 1934) and December 22, 1851 (Clark 1973). Yoshiyama et al. (2001) suggest that although fall run stragglers cannot be discounted, it is somewhat more likely that late-fall-run fish would have been present in a physical condition that could be described as “fine,” and that the timing seemed extraordinarily early for spring-run. Woodbridge Dam, located at the valley town of Woodbridge, provided “often too little water for the passage of salmon" (Fry 1961), and the small fishway at the dam had very little water flowing down it during summer and fall (Clark 1929). Clark also reported that only a fall run occurred, "usually quite late." The flashboards in Woodbridge Dam were taken out in November to allow salmon past. Yoshiyama et al. (2001) suggested this may be an indication of a late-fall run, but that it seemed more likely that the fish for the most part were a late running fall run, delayed by the lack of water stored behind dams. The true late-fall run probably would not have been present in the Mokelumne River or other tributaries in significant numbers until December at the earliest.

Historically, the Stanislaus River supported spring and fall-run Chinook salmon and steelhead and was believed to support small populations of late-fall-run Chinook salmon. The spring-run was the primary run, but after construction of flow regulating dams the fall run became predominant (Yoshiyama et al. 2001). Yoshiyama et al. (2001) reported that as of 1995 there was essentially only the fall run, although small numbers of late-fall-run fish were said to occur (DFG 1993). A smaller run in the winter (most likely late-fall-run fish) reportedly occurred in the Stanislaus River in earlier times (DFG 1972). Yoshiyama et al. (2001) suggests late-fall-run salmon seen in recent years could be strays moving in from the Sacramento River system.

Methods

Information about salmon and steelhead presence in the Calaveras River was obtained from three sources: 1) anecdotal, 2) museum and newspaper archives, and 3) state and federal agency documentation including reports, files, and surveys. In many cases, anecdotal observations were corroborated by documented observations. Anecdotal stories were gathered from interviews of residents of the watershed in San Joaquin and Calaveras counties, located through notices published one time in local San Joaquin and Calaveras County newspapers and a one-time bill insert mailed to Calaveras County Water District (CCWD) customers. Interview questions focused on obtaining as many details as respondents could recall regarding year, season or month, location, and conditions when they saw salmon or steelhead in the river. Bank of Stockton archives of The Record (formerly The Stockton Record) and Stockton Evening Mail newspapers from 1900 to 1940s were reviewed for early stories documenting salmon or steelhead. Primarily spring and fall issues of the newspapers were reviewed to increase the likelihood of locating pertinent stories. Appendix A, Table 2 contains transcripts of interviews with individuals providing anecdotal observations and a bibliography of documented observations.

Data from all these sources were broken out by year, location of observations, water-year type, season, and whether before or after New Hogan Dam was built. Pre- and post-dam periods correspond to the construction of New Hogan Dam in 1964. Location data consists of either specific locations (for example, the Jenny Lind bridge) or general reach or segment (for example, upstream of Jenny Lind, or downstream of Bellota Weir). Observations were reported as either specific months or seasons. General seasonal references for this study were interpreted as fall (September 1 to November 30), winter (December 1 to February 28), spring (March 1 to May 31), and summer (June 1 to August 31). These month ranges correspond best to distinctions made by interview respondents regarding seasonal events or conditions, and similar observations reported by other sources for which a month was known. For example, respondents who stated "fall" as a season often identified the month as November, and identified spring as March, April or May, or when trout-fishing season opened, which was typically early May. In cases where respondents could only specify an entire decade (for example, the 1940s) or range of years within a decade (for example, the late 1940s) when they recalled observing salmon or steelhead, the observation was assigned to the decade in general. Tallies of observations, regardless of source, include only observations associated with an individual year and observations attributed to decades or portions of decades are omitted. Only observations of adult salmon were included in reported tallies.

Hydrology analysis was performed using flow data from three gauges, Jenny Lind (United States Geological Survey No. 11309500, period of record 1907-1966), New Hogan Dam (USACE NHG, period of record 1964-present), and Mormon Slough at Bellota[1] (USACE No. MRS, period of record 1989-present). Data from several other no longer used gauges at Bellota Weir and in the Stockton Diverting Canal (Figure 2), a connecting channel leading to Mormon Slough and part of the migratory pathway, were not used because they were either relocated several times, the gauge was considered inaccurate due to influence of the fluctuating pool level behind Bellota weir during irrigation season, or the gauge may have been tidally influenced. Water year type designations (wet, above normal, below normal, dry and critical) are from the California Department of Water Resources (DWR) Chronological Sacramento and San Joaquin Valley Water Year Hydrologic Classification Indices (http://cdec.water.ca.gov/cgi-progs/iodir/wsihist).

Migration opportunity was evaluated by comparing all documented and anecdotal observations, including observations attributed to decades or portions of decades, to average daily flows at Jenny Lind, New Hogan Dam, and Mormon Slough (after 1997) at the time of the observations. Flows examined in this comparison are those that exceeded 0.7, 1.4, 2.8, and 5.6 m^3s^{-1} (25, 50, 100, and 200 ft^3 sec^{-1}) for a minimum of four days, the migration opportunity criteria for this study. The 0.7 to 5.6 m^3s^{-1} (25 to 200 ft^3 sec^{-1}) flows represent the range of flows demonstrating the presence of salmon in the river under low flows. In addition, this flow range represents flows for which the river could be potentially managed in the future. Four days is the average amount of time it could take a salmon to travel 28.8 km (18 miles) from the river mouth upstream to Bellota, based on studies by Allen and Hassler (1986), Goldstein et al. (1999), Gray and Haynes (1979) and Heifetz (1982). Alternatively, FFC biologist Trevor Kennedy stated it could take only one day or less for healthy adult Chinook salmon to reach Bellota. He bases this conclusion on telemetry data of salmon migrating up the Cosumnes River in which he found fish traveled distances greater than 56 km (35 miles) in less than 24 hours even when passage was difficult at some locations (Kennedy, 8 September 2004).

Results

Chinook Salmon

Only data for the years 1930-2002 were available. No data were found for the period 1900-1929. No early newspaper stories were found of salmon harvesting or sport fishing for either the Calaveras River or neighboring rivers. Winter and summer observations came primarily from documented sources. Tables 1 and 2 summarize spawning observations and juvenile salmon observations, respectively. There are more individual year documented and anecdotal

[1] Only data from 1997 on is considered useable due to prior years' operational problems (R. Johannet, USACE, pers.comm.).

observations after 1964 (35 and 16, respectively) than before 1964 (0 and 3, respectively). This is likely because no official records were kept before 1964 and fewer long time or elderly residents are alive or could be located, and it was more difficult for respondents to recall a specific year for their earliest pre-1964 recollections.

DFG surveys during the winter and spring in the 1970s and early 1980s and USFWS fall migration surveys since 2001 resulted in more fall (September 1-November 30) and spring (March 1-May 31) season adult observations being documented overall. Counting both documented and anecdotal observations, more salmon observations overall occurred in fall and spring. Nine observations occurred in fall, 13 in spring, seven in winter and one in summer (June 1-August 31). Overall, salmon were observed in more seasons during wet years than all other water-year types. There were ten observations in wet years, four in above normal, three in below normal, seven in dry and four in critical years.

Anecdotal, individual year observations, for adult salmon were found for fall (September 1-November 30), winter (December 1-February 28) and spring (March 1-May31) seasons prior to 1964. Documented evidence for adult salmon exists for all four seasons after 1964. Before 1964, observations were found for fish in spring in dry and critical years and in fall in below normal years. After 1964, fish observations were found for wet years in spring, fall, winter and summer (June 1-August 31). In dry years, fish observations were found for fall and winter seasons. In above normal years fish observations were found for spring and fall seasons and in below normal years fish observations were found for spring. In critical years observations of fish were found for winter.

After 1964 fewer observations were found for fish upstream of Bellota in fall (2 observations) even though more than three times as many fish observations were found downstream of Bellota (7 observations). In contrast, after 1964 more spring time observations were found for fish upstream of Bellota (9 observations) than downstream of Bellota (6 observations). Observations of fish after 1964 were found for both upstream and downstream of Bellota in most wetter and drier water-year types. Generally, during spring more fish observations were found upstream of Bellota in wetter years than in drier ones. However, across all seasons, fewer observations were found of fish upstream of Bellota in drier years (3 upstream versus 7 downstream). Summaries of documented and anecdotal Chinook salmon and steelhead observations follow.

Table 2. Reports of spawning Chinook salmon in the Calaveras River.

Spawning Reports			
Year	*Season*	*Location*	*Source*[a]
1930-39	Spring	Calaveras River Park downstream of old Hogan Dam	Fred “Bud” Day
1940-44	Spring	Calaveras River Park downstream of old Hogan Dam	Fred “Bud” Day
1945-49	Spring	Mallard Bend downstream Jenny Lind bridge	John Prioli
1960-69	Fall	Mormon Slough between Fine and Flood Roads	Fred Solari
1972	April-May	Calaveras River upstream of Bellota; no location reported	Anecdotal DFG (1975c)
1975	April-July	Downstream of New Hogan Dam	DFG (1975d)
1997	Fall	Between Fine and Flood Roads	Fred Solari
2001	December	Mormon Slough downstream of Bellota Weir	DWR 2003, FCC 2004

2002	December	Mormon Slough downstream of Bellota Weir	DWR 2003, FCC 2004

a. All sources referenced in Appendix A.

Table 3. Reports of juvenile Chinook salmon in the Calaveras River.

Juvenile Reports				
Year	*Season*	*Description*	*Location*	*Source*[a]
1949	Spring	juveniles	University of the Pacific	John Prioli
1950	March	juveniles	University of the Pacific	John Prioli
1973	April	yearling	Downstream of Bellota	DFG 1975c
1974	April	yearling	Downstream of New Hogan Dam	DFG 1974a
1977	February	yearling	Upstream of Jenny Lind	USFWS 1989
1987	June	yearling	Upstream of Bellota	USFWS 1989, 1993
1995	Spring	smolt	UOP	Tom Taylor
1996	Feb-June	juveniles	Between Bellota and New Hogan Dam	DFG 1996

a. All sources referenced in Appendix A.

Documented Observations

Pre-water development documentation of salmon runs is extremely limited although humans have used the Calaveras River and its tributaries for thousands of years, and there are archeological sites in the area with evidence of Native Americans. The Miwok tribe commonly used the area for hunting and fishing. The historian Sanchez (as cited in DFG 2001) noted entries in Moraga's diary referring to river tribes fighting against Sierra tribes for possession of the salmon in the river. Fenenga (1969) excavated middens on the north bank of Mormon Slough, 4.8 km east of the city of Stockton, and recovered spearing artifacts likely used for salmon. According to Tinkham (1880), Stockton Slough (a former branch of the Calaveras River's valley floodplain that connected with the San Joaquin River) contained, "an abundance of every description of fish. There are salmon, trout, sturgeon, and an infinite variety of the smaller kinds to the hearts content." Gobalet et al. (2004) reviewed the record of fish remains from California archeological sites and found *Oncorhynchus* (Chinook salmon or steelhead trout) remains were recorded for Calaveras and San Joaquin Counties.

The USFWS (1993) reported unconfirmed reports of large runs of adult anadromous salmonids entering the Calaveras River in the early 1900s and the existence of a small population of fall-run Chinook salmon prior to construction of New Hogan Dam. In the 1940s, Stockton illustrator, Ralph Yardly, drew early Stockton scenes from photographs including two scenes depicting early winter flooding in 1906 and 1907 in Mormon Slough (Figure 6 provides one example). In the scene men are shown standing on a bridge over the flooded channel with gaff hooks, poised to spear fish coming up river. The gaffs held by the anglers, and the time of year, suggest the presence of salmon. DFG (1963) noted that "occasionally steelhead and king salmon enter the drainage but only in insignificant numbers and at irregular intervals," which Yoshiyama et al. (2000) consider almost certainly fall–run Chinook. Clark (1929, as cited in Yoshiyama et al. 2001) reported that the river was "dry most of the summer and fall" and so had no salmon. Clark may have been only considering a fall-run of salmon. E. Gerstung, retired DFG fishery biologist, considered the stream habitat of the north and south forks upstream of New Hogan Dam marginal for salmon with no over-summering habitat for spring-run fish[2]. A 1960 USFWS report

[2] Gerstung is associated in Yoshiyama et al. 2001 with a general statement about the Calaveras River having probably always been marginal for salmon and lacking suitable spawning habitat for spring Chinook salmon. In a

titled “A Detailed Report on Fish and Wildlife Resources Affected by New Hogan Project, Calaveras River, California, October 1960” documented the presence of Chinook salmon in the river (as cited in USACE 1981). A 1980 USFWS planning aid letter (as cited in USACE 1981) used historic quantity and timing of streamflow to estimate that about 2,000 winter-run Chinook salmon and 500 fall and spring-run Chinook salmon, and 500 steelhead trout could have ascended the river to spawn prior to construction of New Hogan Dam.

Post-New Hogan Dam observations of salmon are more common. DFG (1993) documents a run of salmon in winter that spawned in late winter and spring, but said it is unknown whether it existed before the river was dammed. This winter run was documented by DFG six times from 1972 to 1984 and numbered 100 to 1,000 fish annually. Yoshiyama et al. (2000) do not consider this winter run an indigenous natural run because the Calaveras River originally did not have year-round conditions suitable to support the native winter run. These authors assert that the stock established itself as a result of coldwater releases from New Hogan reservoir and later was extirpated by the multi-year severe drought of the late 1980s.

In recent years, fall-run salmon entered the river in the 1995, 1997, 1998, 2000, 2001 and 2002, 2003, and 2004 when suitable fall stream flows occurred and under a variety of water year types, including wet, above normal, below normal and dry. These runs were documented by either DFG, FFC, DWR, or in The Record, a Stockton newspaper. Observed fish numbered from fewer than a dozen to several hundred in fall 1995 (DFG unpublished data, as cited in Yoshiyama et al. 2001). During February through June 1996 DFG biologist Maury Fjelstad conducted juvenile Chinook surveys and found age 0 + Chinook salmon juveniles rearing in the river between Bellota and New Hogan Dam indicating the 1995 run had spawned successfully (DFG 1996). Up to 28 salmon were documented by FFC biologists in Mormon Slough in fall and winter 2003 and 2004 including several in December 2004 (in a dry water year) found stranded in the old Calaveras channel (FFC unpublished data).

Anecdotal Observations

Residents living along Mormon Slough and anglers fishing upstream have observed salmon in the Calaveras River on numerous occasions. Pre-1964 observations include those of Stockton resident, Ray Schenone, who in March 1955, a dry water year, found 200 - 300 salmon trapped in the pool downstream of an old railroad trestle in Mormon Slough at Potter Creek (Figure 2). The salmon were unable to pass the boulders and riprap put in the channel to protect the trestle. Schenone said the salmon generally came up “with the floods” and were not noticed because they “moved right through” and the water was turbulent and deep in Mormon Slough. Mike Machado of Stockton saw salmon at Bellota Weir in the spring of 1960, a critical water year, when he was 12 years old. Another Stockton resident, John Prioli, recalled attempts to snag salmon or steelhead from “deep ponds” near the Jenny Lind Bridge (Figure 2) while fishing for black bass in February through April in the mid- to late-1940s. At the same time, he also recalled seeing salmon spawning at Mallard Bend (Figure 2), a wide bend in the river downstream of the bridge. Prioli trapped juvenile salmon in the river behind the University of the Pacific campus

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June 2004 conversation with the author, Gerstung noted that he had never worked on the lower Calaveras River and was referring to the upper river upstream of New Hogan Dam. His opinion of the habitat was based on the over-summering requirements of spring-run salmon and what he knew of the largest upstream tributaries, the north and south forks. He considered them too small to support spring-run salmon over the summer months.

(Figure 2) in the spring of 1949 and 1950, both below normal water years, with his college biology instructor, Verna Johnston. Fred Solari of Stockton recalled his father's stories of catching salmon in the 1930s and 1940s in the fall from Mormon Slough where the old Solari grocery is on Highway 26 and Fine Road east of Linden (Figure 2). Solari said that before Mormon Slough was modified in the late 1960s it was "more wild". It had pools as deep as 9 m (30 ft), tree-lined banks, and waterfalls over hardpan drops. These pools were eliminated when the channel was flattened and widened to make a larger flood control channel. Fred Day, a 90-year-old life-long Calaveras County resident, saw salmon whenever there was a "wet spring" during the 1930s and early 1940s. From 1930-1944 he worked at the then just-completed Hogan Dam with his brother and cousin. In his account of his recollections, he says:

> "I was working at Hogan Dam about four to five years after it was completed and recall the water flows being extremely heavy during spring-runoff. The winter had been severe and there was considerable snowmelt, which produced a very heavy flow. It was March or April and it had been raining for two to three days. The water was so high behind the dam that all nine water outlets, holes in the dam, were gushing full-time, and water covered the bridge and the cattle fencing all around the river. There was a 90 cm (3 ft) wide catwalk at the bottom of the dam. I, my brother and cousin saw lots of salmon trying to come through the holes in the dam, some falling down the face of the dam, some hitting the valves at the bottom of the dam as they fell. The salmon fell across the catwalk and were longer than the catwalk was wide. The salmon leaped at the water gushing out of the holes. Some of the leaping salmon made it through to the upstream side of the dam. Later that spring or early summer I walked upstream of the dam after all the water had gone down. Large sand flats were left behind. I found salmon skulls with big hooked jaws up there. I saw salmon in the Calaveras downstream of the dam most every spring when the water flows were high. The wet years were when I saw the most salmon. I do not recall seeing a fall run of salmon, which would not have been possible most years because there was not enough water then to support the fish coming up the river."
>
> "I saw salmon many times downstream of the old Jenny Lind bridge, which spanned the Calaveras and led to the town of Milton. Fish 90 cm (3 ft) long were common there. I also caught steelhead from the old bridge. Salmon were seen regularly at Calaveras River Park, about 90-180 m (100-200 yds) downstream of the dam, in a large swimming hole that probably measured 21-24 m (70-80 ft) across. I and my wife would catch steelhead in this pool in spring and early summer. The salmon spawned there. One of my jobs was to maintain the rain gauge near Bellota and I would see salmon at Bellota. As a boy, I fished the local tributary streams for trout; these were Jesus Maria, O'Neill Creek, Murray Creek and others. I caught trout in nearly every stream in this county. I also fished the Calaveras River upstream of Hogan Reservoir, and found skeletons of salmon with big, hooked jaws upstream of San Andreas (Figure 2) in an area known as The Narrows".

After the 1964 construction of New Hogan Dam anecdotal observations continued to occurr during the spring and fall, then the winter and more recently only during fall. Brian Cudney of Valley Springs recalled catching a salmon upstream of Bellota in the spring of 1966, a below normal water year. Fred Solari saw salmon upstream and downstream of Bellota Weir in the fall during the 1960s, even spawning in Mormon Slough, though he could not recall specific years so it is not clear whether these observations were pre- or post-New Hogan Dam. While fishing at the opening of trout season in the spring in the 1970s, Jeff Andrews of San Andreas recalled seeing runs of very large, scarred and beat up salmon between New Hogan Dam and Jenny Lind. During that time he saw another angler catch a 91.5 cm (36 in) salmon that was fresh and still had good color. In March 1972, a dry water year, Schenone caught four salmon at Jack Tone Road bridge in Mormon Slough. These 1970s observations are supported by DFG documentation from the same period.

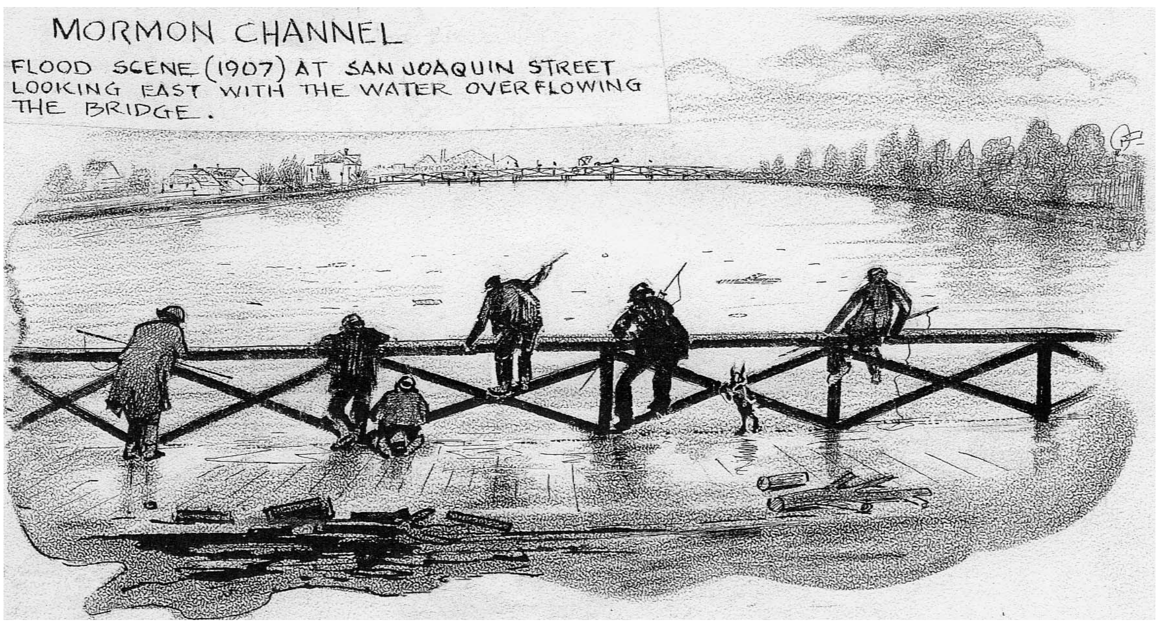

Figure 6. Flooded Mormon Channel, Stockton, 1907. Haggin Museum Library Archive, Stockton, California.

Steelhead

Some anecdotal and a few documented sources exist for steelhead. Local anglers reported catching steelhead from the Calaveras River in spring and early summer in the 1930s, November to January in the 1940s, 1960s and 70s, and in spring in 1998, a wet water year. In the 1930s, Fred Day and his wife caught steelhead in the Calaveras River Park pool (about 90-180 m, or 100-200 yds) downstream of former Hogan Dam, now inundated by New Hogan Dam) in spring and early summer, and he also caught steelhead from the Jenny Lind bridge. As a youngster in the early 1940s, John Prioli recalled seeing salmon and steelhead in the river while walking the gold-dredged areas upstream from November through January. Brian Cudney of Valley Springs recalled catching steelhead in the fall or winter from the Jenny Lind bridge in the 1960s and 1970s. In spring 1998 Fred Solari caught two 46 cm (18 in) steelhead between Fine Road at Avisino Dam in Mormon Slough. Ninety-two-year-old (at the time of the 2002 interview) Murphys resident, Lois Ostrowski Schachten, recalled that her husband and young sons fished for steelhead on the Calaveras River in the spring, usually in May (author's note: this was likely around the 1940s). Her sister-in-law, Maisi Schachten, was born and reared in the town of Murphys on the Stanislaus River. Over 50 years ago, her husband fished the Stanislaus with local Indian friends, as did his father in the late 1800s. They caught steelhead by the basketfuls just upstream of Murphys at 651.3-m (2, 171 ft) elevation, an elevation similar to major Calaveras River tributaries with permanent flows and reported trout populations.

On March 5, 1979, DFG biologist Charlie Young observed 35.5-40.6 cm (14-16 in) rainbow trout or steelhead attempting to negotiate Bellota Weir, and 1.8-2.7 kg (4-6 lb) steelhead downstream of the weir, as well (DFG 1979). In March 2000, the DFG documented steelhead and resident rainbow trout stranded downstream of New Hogan Dam after flood control releases were suddenly decreased. In April 2002, FFC biologists found a 73-cm (28.75 in), half-dead and spawned-out female steelhead upstream of the low-flow crossing downstream of Bellota weir. FFC biologists also found several live and dead adult steelhead in Mormon Slough in late March and early April 2002 along with steelhead redds in riffles downstream of Bellota Weir. Yearling trout, possibly steelhead smolts, were also captured in the same area (FFC 2004). In fall 2002 the FFC and SPC found dead adult steelhead in both Mormon Slough and the old Calaveras channel downstream of Bellota, presumably having over-summered in deep pools formed behind irrigation flashboard dams but then died when the irrigation season ended, irrigation flows down the channels were stopped, and the channel became dry (FFC 2004). FFC snorkel surveys of the lower river downstream of New Hogan Dam in 2002 indicate a large population of rainbow trout exists and naturally reproduces in the reach (FFC 2004). While conducting fish passage surveys in Mormon Slough from November 2003 to March 2004, FFC biologists documented live outmigrating *O. mykiss* pars (smolt index 3 to 5) in the pool directly downstream of Bellota Weir and further downstream. Since January 2002 SPC has intermittently monitored outmigrating rainbow trout (*O. mykiss*) with a screw trap at Shelton Road, upstream of Bellota. Biologists have documented smolt size fish (smolt index size ≥ 5) each year with 146 smolts in 2002, 103 in 2003, 194 in 2004, and 34 in 2005 (data are numbers of captured fish, not expanded data) (SPC unpublished data).

Migration Opportunity

In most years, average daily flows in the Calaveras River in fall, winter, and spring from 1930 to 2004 met the migration opportunity criteria (flows exceeding 0.7, 1.4, 2.8, and 5.6 m^3s^{-1} (25, 50, 100, and 200 ft^3 sec^{-1}) for a minimum of 4 days.) In each decade flows were available in the year and season when adult Chinook salmon and steelhead observations were made. The overall percentage of average daily fall flows meeting the migration opportunity criteria is higher after New Hogan Dam was built. The percentage of average daily winter and spring flows meeting the migration opportunity criteria are more similar between the pre- and post-dam periods (Figure 7).

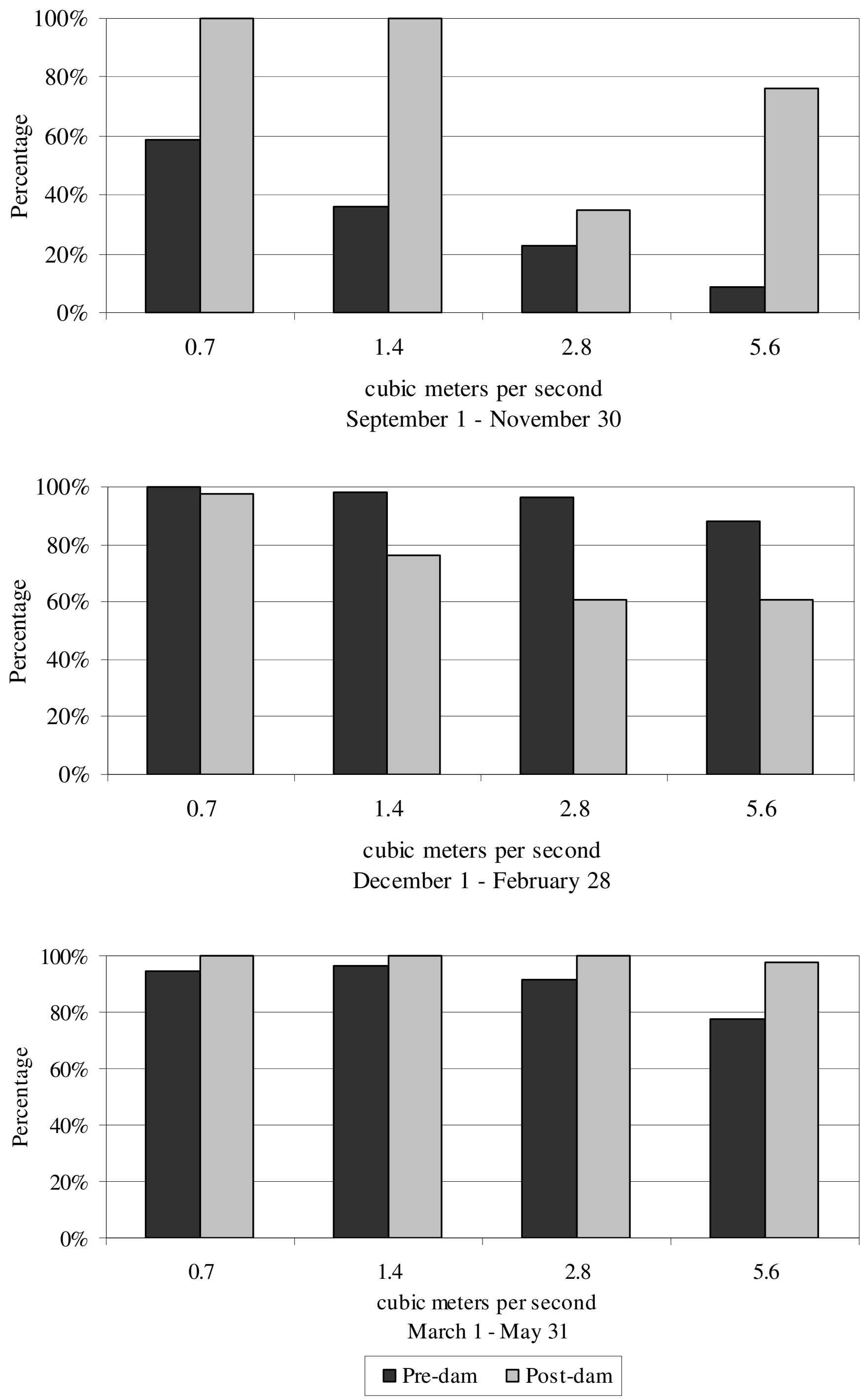

Figure 7. Percentage of years by season in which average daily flows exceeded 0.7, 1.4, 2.8, and 5.6 m^3s^{-1} (25, 50, 100, and 200 ft^3 sec^{-1}) for at least 4 days over period of record before and after New Hogan Dam regulated the river. Data: Jenny Lind 1907-1964, USGS. New Hogan Dam 1965-2002, USACE.

Detailed analyses for one pre-dam and one post-dam period, the 1940s and the 2000-2004, respectively, illustrate that flows were adequate for the collected observations to have occurred. River flows during the 1940s provided opportunities for juvenile salmonid out migration and adult steelhead and fall-, late fall- and spring-run salmon to migrate to Bellota and move upstream. In the 1940s salmon were observed in the fall in Mormon Slough and upstream of Bellota, in spring at Bellota and upstream at Jenny Lind and Hogan Dam, and in the winter upstream of Bellota. Spawning was observed in spring downstream of Hogan Dam. Juveniles captured in spring 1949 and spring 1950 in the Old Calaveras channel (Figure 2) indicate spawning occurred in fall 1948 and fall 1949. Adult salmon were observed upstream of Jenny Lind in fall 1949, a below normal year. According to observations by Trevor Kennedy, FCC biologist, flows less than 2.8 m^3s^{-1} (100 ft^3 sec^{-1}) have been enough to attract salmon into the river downstream of Mormon Slough and into Mormon Slough itself. During the 1940s such flows would have been generated by rainfall and runoff caused by storms. In 1948 fall flows did not exceed even 0.57 m^3s^{-1} (20 ft^3 sec^{-1}) until early November for a few days at a time. Spawning fish may not have had migration opportunities until December when flows exceeded 0.7, 1.4, and 2.8 m^3s^{-1} (25, 50 and 100 ft^3 sec^{-1}). In fall 1949 flows at Jenny Lind did not exceed 0.7 m^3s^{-1} (25 ft^3 sec^{-1}) for any 4 day period, although flows between 0.45 – 1.1 m^3s^{-1} (16-38 ft^3 sec^{-1}) did occur in early and mid-November and 1.7 m^3s^{-1} (62 ft^3 sec^{-1}) from November 29 through December 2. Such flow spikes could have attracted fish into the river. Fall flows at Jenny Lind exceeded 0.7 m^3s^{-1} (25 ft^3 sec^{-1}) in many years and also exceeded 1.4, 2.8, and 5.6 m^3s^{-1} (50, 100, and 200 ft^3 sec^{-1}) in several years. Spring flows met the migration opportunity flow criteria in all years as did winter flows except in 1948 (Table 4). Subsequently, winter and spring-time flows in 1948 and 1949 could have been sufficient to provide migration and spawning flows in the river upstream.

Table 4. Years 1940-49 in which average daily flows exceeded 0.7, 1.4, 2.8, or 5.6 $\mathbf{m^3s^{-1}}$ (25, 50, 100 and 200 $\mathbf{ft^3\ sec^{-1}}$) for at least 4 days over period of record in Fall, Winter and Spring at Jenny Lind.

Year Type	Year	Fall September 1 - November 30				Winter December 1 - February 28				Spring March 1 – May 31			
		0.7+	1.4+	2.8+	5.6+	0.7+	1.4+	2.8+	5.6+	0.7+	1.4+	2.8+	5.6+
AN	1940	x				x	x	x	x	x	x	x	x
W	1941					x	x	x	x	x	x	x	x
W	1942	x	x	x	x	x	x	x	x	x	x	x	x
W	1943	x				x	x	x	x	x	x	x	x
BN	1944	x	x	x	x	x	x	x	x	x	x	x	x
AN	1945	x	x			x	x	x	x	x	x	x	x
AN	1946	x	x	x		x	x	x	x	x	x	x	x
D	1947	x				x	x	x	x	x	x	x	x
BN	1948					x	x	x		x	x	x	
BN	1949					x	x	x	x	x	x	x	x

Flows during 2000-2004 provided the opportunity for juvenile salmonid out migration and adult steelhead and fall-run salmon migration into Mormon Slough. Salmon were stranded in Mormon Slough in fall 2000, an above normal year, and in fall 2001 and fall 2002, both dry years. In late November 2001 fish were stranded in the Stockton Diverting Canal at Budiselich Dam. Peak flow that month at the Mormon Slough gauge was 0.65 m^3s^{-1} (23 ft^3 sec^{-1}) and at New Hogan Dam it was 1.9 m^3s^{-1} (66 ft^3 sec^{-1}). USFWS biologist Gonzalo Castillo and FFC biologist Trevor

Kennedy reported stranding in late November at Budiselich Dam in 2002 and 2003 when peak recorded flow at Mormon Slough was less than 0.28 m^3s^{-1} (10 ft^3 sec^{-1}) and at New Hogan Dam 1.4 m^3s^{-1} (50 ft^3 sec^{-1}) and 1.2 m^3s^{-1} (44 ft^3 sec^{-1}), respectively. The FFC conducted surveys for Chinook salmon in Mormon Slough in Fall 2003 and 2004 and found live and dead salmon stranded in various locations from tidewater to Bellota Weir (FFC unpublished data). In addition, several live and dead steelhead were found in Mormon Slough in March and April 2002 along with steelhead redds. Snorkel surveys downstream of New Hogan Dam in 2002 indicated a large rainbow trout population. From November 2003 to March 2004 FFC biologists documented outmigrating *O. mykiss* smolts in the pool downstream of Bellota and downstream in Mormon Slough. In addition, since January 2002 SPC biologists have documented smolt size fish upstream at Shelton Road. Fall flows at New Hogan Dam exceeded 5.6 m^3s^{-1} (200 ft^3 sec^{-1}) in 2000, 2001, and 2002 (Table 5). Fall flows in Mormon Slough exceeded 0.7 (25 ft^3 sec^{-1}) and 1.4 m^3s^{-1} (50 ft^3 sec^{-1}) in 2000 and 2001, and only 0.7 m^3s^{-1} (25 ft^3 sec^{-1}) in 2002 and 2003 (Table 6).

Table 5. Years 2000-05 in which average daily flows exceeded 0.7, 1.4, 2.8, and 5.6 m^3s^{-1} (25, 50, 100 and 200 ft^3 sec^{-1}) for at least 4 days over period of record in Fall, Winter and Spring at New Hogan Dam.

Year Type	Year	Fall September 1 - November 30				Winter December 1 - February 28				Spring March 1 – May 31			
		0.7+	1.4+	2.8+	5.6+	0.7+	1.4+	2.8+	5.6+	0.7+	1.4+	2.8+	5.6+
AN	2000	x	x	x	x	x	x	x	x	x	x	x	x
D	2001	x	x	x	x	x	x			x	x	x	x
D	2002	x	x	x	x	x				x	x	x	x
BN	2003	x	x	x		x	x			x	x	x	
D	2004	x	x	x		x	x			x	x	x	

Table 6. Years in which average daily flows exceeded 0.7, 1.4, 2.8, and 5.6 m^3s^{-1} (25, 50, 100 and 200 ft^3 sec^{-1}) for at least 4 days over period of record in Fall, Winter and Spring at Mormon Slough.

Year Type	Year	Fall October 15-November 30				Winter December 1 - February 28				Spring March 1 – April 15			
		0.7+	1.4+	2.8+	5.6+	0.7+	1.4+	2.8+	5.6+	0.7+	1.4+	2.8+	5.6+
W	1998	x	x	x		x	x	x	x	x	x	x	x
AN	1999	x	x			x	x	x	x	x	x	x	
AN	2000	x	x			x	x	x	x	x	x	x	x
D	2001	x	x			x	x	x	x	x	x	x	x
D	2002	x				x	x	x	x	no data	no data	no data	no data
BN	2003	x				x	x			x	x		
D	2004					x	x	x	x	x	x	x	x

Discussion

Several factors including Calaveras River hydrology, migration opportunity, salmonid life history, and documented historical presence of these fish in the San Joaquin River and in neighboring drainages of the San Joaquin River Basin lend support to the historical presence of Chinook salmon and steelhead in the Calaveras River. The conclusions of Lindley et al. that several Calaveras River tributaries upstream of New Hogan Dam had summer rearing habitat for anadromous *O. mykiss* and had an historical independent population of steelhead are supported by the collected anecdotal and documented information presented in this study.

Fall observations of salmon in the Calaveras river both upstream of and downstream of Bellota consisted of migrating fall run presumably making their way upstream to spawn. In the post-New Hogan Dam period fall migration presents a special challenge. Fewer overall observations of salmon upstream of Bellota than downstream suggests that in very low water years, fish were less successful in migrating upstream of Bellota even in spring-time when flows typically were higher. In wet springs, more observations occurred upstream of Bellota than downstream. Salmon migrating in fall, even in wet years, appeared less successful in migrating upstream of Bellota than fish migrating in the spring, likely due to downstream barriers and lower fall flows in Mormon Slough leading to stranding. Juvenile fish caught in the spring before 1964 were likely progeny of fall or late-fall run spawners. By the 1990s and 2000s, only fall run have been documented in the river, primarily in Mormon Slough where their upstream migration is stopped by Bellota Weir or other downstream barriers, and lack of flow in the channel. Even though adequate flows may be released from New Hogan Dam, the water is diverted at Bellota, leaving migrating fish dependent on rain run-off or rare storm releases from New Hogan Dam for flows downstream of Bellota Weir. Bellota Weir, located in the valley portion of the Calaveras River, has had a similar impact on salmon and steelhead runs as Woodbridge Dam has had on runs in the Mokelumne River.

Strong evidence suggests late-fall run occurred in the Stanislaus, the Mokelumne, and the Calaveras Rivers. In reviewing historical documentation by Jordan (1892, 1904) of a run in December in the Sacramento and smaller rivers southward Yoshiyama et al. (2000) comment that none of the Central Valley streams south of the Sacramento River had summer flows suitable for winter-run salmon spawning and incubation periods. Therefore, Jordan (1892, 1904) was likely observing a late-fall run in which adult migration and spawning are concentrated in January to April, or, perhaps a very late running segment of the fall run. A late-fall run could also explain the observations of adults in early winter, or December through January on the Calaveras River. Anecdotal observations from the 1930s and 1940s, like those of John Prioli, commonly reported adult salmon in the river during spring, designated as March 1-May 31, and reported spawning in February, March, or April. This pattern corresponds well with the late-fall run life history timing suggested for the San Joaquin River Basin. Although fall-run fish can also migrate in late fall and early winter, the spring spawning period observations argue for late-fall run fish. While water flows occurring after 1964 might have attracted a winter run of salmon into the river and provided spawning and rearing conditions upstream of Bellota Weir, late-fall run fish would likely have been able to take advantage of these migration and spawning conditions, as well. Late-fall run on the Calaveras River may now be extirpated and the run is considered sporadic and not self-sustaining on the Calaveras River (Yoshiyama et al. 2001). The run is not known to have occurred in the Cosumnes and may be extirpated from the Mokelumne.

The percentage of years with average daily spring flows that meet the migration opportunity criteria is slightly higher after New Hogan Dam. Salmon continued to be observed in the Calaveras River in spring until 1966. A remnant spring-run could have persisted in the Calaveras River until the construction of New Hogan Dam as they are thought to have occurred in the

Mokelumne River until construction of Camanche Reservoir. Thus, it was likely loss of access to upstream reaches above the dam, rather than a reduction in spring migration opportunity flows, that extirpated spring run from the Calaveras River. While fish were observed migrating or spawning in the spring and early summer in the 1930s, 1940s and 1950s, it is not known if these fish over-summered in the river or spawned in the fall. Where and when would spring-run on the Calaveras have spawned? There are no collected observations of salmon upstream in the late summer or early fall, August to October, or of adult salmon in pools upstream of Bellota during summer. Spring-time observations of salmon were more likely because more observers reported visiting the river to fish for steelhead or trout in the spring, but did not often frequent the river in summer or fall. Frank Pitto, Calaveras County resident since 1928, fished the river around old Hogan Dam in late summer and early fall when the river had dried up and only disconnected pools remained. He reported fishing the holes for catfish and didn't see salmon. However, it is more likely salmon would have utilized deep summer pools in the canyon downstream, between New Hogan Dam and Jenny Lind, an area difficult for anglers to access. The months August to October are potentially a period when the river would have been composed of disconnected pools and dry reaches. If the spawning period is shifted a month later, as is the case with the fall run, then perhaps the San Joaquin spring-run could have taken advantage of the early fall rains of November to spawn when the river and its major tributaries reconnected and salmon could have dispersed from holding pools to spawning areas, just as trout were reported to do in upstream tributaries.

The fact that trout were fished from Calaveras River tributary streams at similar elevations as steelhead in the Stanislaus River argues that steelhead were likely historically present in the Calaveras river before it was dammed. Steelhead must have taken advantage of winter and spring flows prior to construction of New Hogan Dam to migrate and spawn upstream where they were sought after by anglers. In recent years, steelhead have been documented using winter and spring flows from rain, runoff, and occasional reservoir flood releases, to migrate up the river, though barriers such as Bellota Weir can stop steelhead once flows recede after a storm. Significant obstacles also impede steelhead smolt outmigration in the fall and winter, including low to no flows, barriers in Mormon Slough and the old Calaveras channel where smolts become stranded, and possible entrainment at the unscreened municipal diversion at Bellota Weir.

Conclusion

Early observations and documentation indicate that fall-, late-fall, and possibly spring-run Chinook salmon and steelhead used the Calaveras River prior to 1964 when New Hogan Dam was completed and prior to other earlier flood control and water development projects. After New Hogan Dam construction, steelhead and fall-run salmon and a run occurring in winter, and spawning in spring and early summer (potentially winter-run salmon), have been documented. While a winter run of fish was documented in the river during the 1970s and 1980s, there does not seem to be evidence of that run before the construction of New Hogan Dam.

The timing and amount of flows in the Calaveras River, both before and after New Hogan Dam, provided ample opportunity for anadromous fish to migrate up the river in the fall, winter and spring seasons when they were observed. As in earlier times, storms create fall or early winter flows that attract fish into Mormon Slough. Comparison of salmon observations and flows in Mormon Slough in the late 1990s and early 2000s demonstrates that flows less than 2.8 m^3s^{-1}

(100 $ft^3 sec^{-1}$) can attract fish into the lower river channel and this was likely the case in the past, as well. However, even though the percentage of average daily winter flows that meet the migration opportunity criteria is higher after New Hogan Dam, Bellota Weir and additional newer structures in Mormon Slough make it nearly impossible for fish to take advantage of storms and migrate upstream unimpeded as they did in the past. After the construction of New Hogan Dam, and subsequent river regulation, such barriers became serious impediments to fish migration, causing stranding when flows high enough to transport fish over the structures drop. New Hogan Dam decreased the percentage of years with average daily flows exceeding 2.8 and 5.6 m^3s^{-1} (100 and 200 $ft^3 sec^{-1}$) between December 1 and February 28, peak months for late-fall run migration. Additionally, there was a dramatic decrease in the number of dry-year flow peaks over 28.3 m^3s^{-1} (1000 $ft^3 sec^{-1}$) between the pre- and post-dam periods. However, even the driest water years in the Calaveras River still had flows exceeding 5.6 m^3s^{-1} (200 $ft^3 sec^{-1}$) in the spring and winter months, enough for fish to migrate and spawn. The combination of instream barriers and fewer high flow events has led to fewer opportunities for salmon to enter the river and move upstream through Mormon Slough to spawning areas upstream of Bellota, even though upstream conditions for spawning were, and are today, adequate. At this point in time, winter and spring flows during non-irrigation season, when most flashboard dams in Mormon Slough are removed (other than Bellota Weir), could still provide opportunity for steelhead and late-fall salmon, and potentially spring-run salmon, to migrate up the river. However, these salmon runs have not been observed in recent years and may be extirpated by now, leaving only the fall run and steelhead available to use the river under the right conditions. The percentage of years with average daily fall flows meeting the migration opportunity criteria increased substantially after New Hogan Dam, but most of this flow does not reach Mormon Slough when fall run arrives in response to flow pulses caused by fall rain storms. Restoring salmonids to the Calaveras River will require improving migration conditions. Migration conditions can be greatly improved by remediating barriers in Mormon Slough so that salmonids can successfully reach upstream spawning and rearing areas during the short periods of high flows occuring after fall and early winter storms and during flood water releases from New Hogan Dam.

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